

(19) World Intellectual Property
Organization
International Bureau



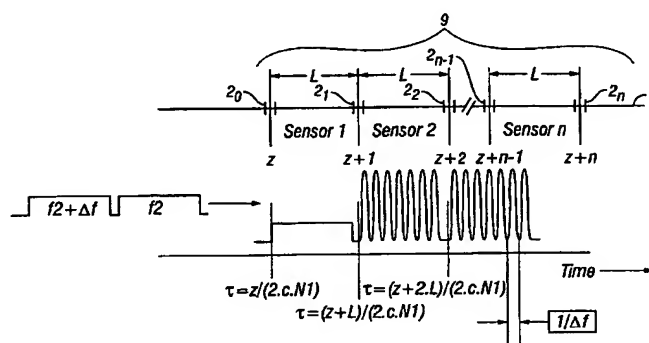
(43) International Publication Date
19 August 2004 (19.08.2004)

PCT

(10) International Publication Number
WO 2004/070346 A3

- (51) International Patent Classification⁷: G01D 5/353, G01K 11/32, G01L 1/24
- (21) International Application Number: PCT/GB2004/000197
- (22) International Filing Date: 20 January 2004 (20.01.2004)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
0302434.6 3 February 2003 (03.02.2003) GB
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- (54) Title: FIBER-OPTIC SENSOR
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report

[Continued on next page]



(57) Abstract: A method of measuring a selected physical parameter at a location within a region of interest comprises the steps of: launching optical pulses at a plurality of reselected interrogation wavelengths into an optical fibber (1) deployed along the region of interest, reflectors ($2_0, 2_1, 2_n$) being arrayed along the optical fibber (1) to form an array (9) of sensor elements, the optical path length between the said reflectors (2) being dependent upon the selected parameter; detecting the returned optical interference signal for each of the reselected wavelengths; and determining from the optical interference signal the absolute optical path length (L) between two reflectors (2) at the said location, and from the optical path length (L) so determined the value of the selected parameter at the said location; wherein the step of determining the absolute optical path length (L) comprises carrying out a process in which the phase difference between the interference signals for a pair of the reselected wavelengths is estimated using an estimated value for the optical path length (L), the estimated phase difference is used to estimate the phase at each of those wavelengths, and the phase thus obtained is used to revise the estimated value for the optical path length (L), the process being repeated for some or all remaining wavelength pairs in sequence, on the basis of the optical path length (L) estimated for the immediately preceding pair in the sequence, thereby to progressively revise the optical path length (L) until it is known to a desired level of accuracy.



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(88) Date of publication of the international search report:
30 September 2004

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB2004/000197

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G01D5/353 G01K11/32 G01L1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01D G01L G01K G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 757 487 A (KERSEY ALAN D) 26 May 1998 (1998-05-26) column 3, line 1 - column 4, line 37; figures 1,2 -----	1,39

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

6 May 2004

Date of mailing of the international search report

02.08.04

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Box II Observations where certain claims were found unsearchable (Continuation of Item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: **3-34, 36-38, 41-72, 74-76**
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of Item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-34, 36-72, 74-76

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-34, 36-72, 74-76

Apparatus and method of measuring a parameter with an optical fibre comprising an array of sensors, wherein the optical path length (OPL) of the sensors is dependent upon the parameter to be measured. The absolute value of the OPL is computed with an iterative algorithm based on an estimation of the derivative of the phase of an optical interference signal as a function of wavelength.

2. claims: 35, 73, 77

Method of measuring a parameter with an optical fibre comprising an array of sensors, wherein an optical interference signal from the sensors is processed to remove the cross-talk term. The method is based on the process of subtracting cross-phases.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 3-34, 36-38, 41-72, 74-76

In view of the large number and also the wording of the claims presently on file, which render it difficult, if not impossible, to determine the matter for which protection is sought, the present application fails to comply with the clarity and conciseness requirements of Article 6 PCT (see also Rule 6.1(a) PCT) to such an extent that a meaningful search is impossible. Consequently, the search has been carried out for those parts of the application which do appear to be clear (and concise), namely an optical fiber with an array of sensors, which are interrogated by launching a plurality of preselected wavelengths along the fiber, and where a method of determining the absolute value of the Optical Path Length (OPL) of the sensors is employed, based on computing the OPL with an iterative algorithm. The iterative algorithm is based on an estimation of the derivative of the phase of an optical interference signal as a function of wavelength. The apparatus and the method of interrogation are disclosed on pages 5, 12, 22-23 of the description and in claims 1, 2, 39 and 40.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

International Application No
PCT/GB2004/000197

PCT/GB2004/000197

Form PCT/ISA/210 (patent family annex) (January 2004)